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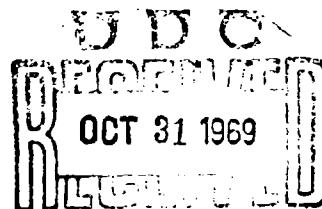
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SOME PROBLEMS IN THE EPIDEMIOLOGY OF DEEP MYCOSES
(Review)

[Following is the translation of an article by V. S. Suvorov and B. G. Val'kov, Volgograd Branch of the Rostov Antiplague Institute, published in the Russian-language periodical Zhur. Mikrob., Epidem. i Immunobiol., (Journal of Microbiology, Epidemiology, and Immunobiology) 45(6): 117-20, 1968. It was submitted on 5 Jun 1967.]

Until now both in Soviet and foreign literature there has been no single opinion relative to the epidemiology of deep mycoses. The majority of investigators consider that the source of infection is the soil or, more accurately, soil of a specific composition in the presence of particular conditions of temperature and humidity (soil and air). Thus Egeberg and Ely (1956), from soil samples taken by them in the northern San Joaquin Valley (USA), detected the spores of the causative agent of coccidioidomycosis in 4.2% of the samples at the end of a dry period and up to 16% at the end of a wet (rainy) period.

Bernard (1960) reports that during an outbreak of coccidioidomycosis among servicemen at Andrews Air Base (USA) viable causative agents of this infection were seeded out of the soil at a depth down to 15-20 cm regularly throughout the entire year. Based on the findings of Zeidberg (1955), *Histoplasma capsulatum* is encountered in 1.6-13.7% of the cases in various places on farms in the state of Tennessee.

Out of 150 soil samples, collected in the desert regions of the state of Arizona, the well-known specialist on pathogenic fungi Emmons (1942) isolated *Coccidioides immitis* in 5 samples. He also considers the soil as the source of infection in the case of diseases of man by a number of deep (systemic) mycoses.

On the basis of a great deal of literary and personal material, Kashkin (1962) shed extensive light on problems of the epidemiology of deep mycoses. However, sometimes he makes questionable conclusions, as it seems to us, without sufficient critical analysis. Thus, with respect to the epidemiology of coccidioidomycosis it is stated that the source of infection is considered to be the soil and endemic sites, and concerning histoplasmosis with reference to the reservoir, that the "reservoir is the soil." In other cases, for example in the case of South American blastomycosis, the sources

of infection are specified as unknown, and in the case of North American blastomycosis the sources of infection are listed as "sick man, plants, and animals." Though superficially, Kashkin makes mention in his manual of the possibility of a natural focalness of deep mycoses. Unfortunately, subsequently this idea did not receive the necessary development.

In the interesting book by the Hungarian specialists Feyer, Olakh, Satmari, Sodorai, and Uri, "Medical Mycology and Fungous Diseases" (1966), problems of epidemiology of deep mycoses are practically left out or are reduced to recognition of the dust factor as the source of human infection.

But meanwhile now, as it seems to us, numerous materials have accumulated which make it possible to shed light on the epidemiology of deep mycoses. However, first of all it is necessary to clarify the main problem of epidemiology - to give a scientific definition of the epidemic process and its main link - the source of infection. On a correct determination of the concept of the source of infection depends the answer to the question of what makes for the uniqueness of the epidemiology of deep mycoses.

As is known, in Soviet literature the following definition is generally accepted: "...as source (or primary source) of infection it is necessary to understand that object which serves as the site for the natural residence and multiplication of the causative agent, in which the process of natural build-up of an infectious onset takes place, and from which the causative agent can infect healthy parties by some means" (Gromashevskiy, 1965).

If one were to stem from this position, based on recognition of the parasitic nature of infectious diseases, the source of infection may be only the infected (sick or sometimes healthy) human and animal organism. This regularity has tremendous theoretical and practical importance.

In accordance with the stated definition the soil, air, water, and items of the external environment cannot be the source of infection, but are only factors of its transmission. And this is in spite of the fact under specific conditions the causative agents of certain infections not only reside for a long time in the external environment, but sometimes find conditions there for their growth and development (the cholera vibrio in water, the typhoid bacillus in milk, etc.).

Such a nature of exclusion only underscores the general biological principle, because the parasitic nature of causative agents of infectious diseases of man predetermines the process of their preservation as an organic species due to parasitism in the organism of man or animal. A pathogenic parasite cannot be

preserved as an organic species if it does not live and multiply at the expense of the organism of man or animal.

From these positions we will examine the causative agents of deep mycoses. The fact of their being found in the soil in a specific phase of their development is generally known at present. But is the soil the medium of their natural residence and multiplication and does the process of natural build-up of the infectious onset take place in the soil?

Up until now not one investigator has been able to establish the fact of formation of spherules of the causative agent of coccidioidomycosis or the yeast phase of development of the causative agent of histoplasmosis under natural conditions in the external environment (soil, water, etc.), outside the organism of man or animal. And it is mainly these tissue phases of development of pathogenic fungi which determine the possibility of their preservation as an organic species. The spores (arthrogenous spores, chlamydespores) of pathogenic fungi, though they are preserved in the soil and on other objects of the external environment for a long time, are only an intermediate phase in the development of the causative agent.

Thus cases of finding the mycelium phase of development of pathogenic fung on objects of the external environment (most often in the soil) cannot serve as a basis for recognition of the soil as the source of infection.

Such a source of infection can only be the living organism of man or animals. Practical confirmation of this can be the facts of exposure of the sick or the carriers of the causative agents of deep mycoses both among man and among animals.

In spite of the absence of proven cases of infection of healthy persons from sick persons, cases of incidence of deep mycoses are exceedingly numerous. It is considered that on the earth there is no less than 10 million persons infected with the causative agent of coccidioidomycosis and more than 30 million with the causative agent of histoplasmosis. In certain regions of the USA the rate of infection of the population with systemic mycoses reaches 90% (Wilson, 1962). The nosogeography of deep mycoses is spreading all the more with each year. Thus, for example, in addition to America the infection of man and animals with histoplasmosis is noted in more than 50 countries and territories of Asia, Africa, Australia, and Europe (Edwards and Kler, 1956; Ajello, 1961; and others). Individual cases of deep mycoses in man have been recorded in the USSR (Araviyskiy, 1958; Kashkin and associates, 1958; Araviyskiy and Kashkin, 1960; Arievidh and St. anisncheva, 1963; and others).

From what and how is man infected? What is the mechanism of transmission of the causative agents of deep mycoses?

Investigations, carried out in various regions of the world, show that in addition to man, many wild and domestic animals are infected with deep mycoses. Thus Emmons (1942), during autopsy of 105 wild rodents close to the village of San Carlos (USA), isolated *Coccidioides immitis* in 25 animals of 6 species: pocket mice, kangaroo rats, ground squirrels, rats of the genus *Neotoma*, and others. In 1949 he reported about his isolation of the causative agent of histoplasmosis in 7 out of 43 gray rats in the state of Virginia.

Large horned cattle in the North American state of Arizona, after 2 years of living in this terrain, give positive reactions to coccidioidomycosis in practically 100% of cases (Wilson, 1962).

Histoplasma capsulatum was isolated from the organs and feces of 3.2% of the bats (*Molossus major*) collected from 14 sites on the Isthmus of Panama (Klite, 1965). Histoplasmosis was recorded in no less than 11 neotropic species of bats in Latin America.

Infection with histoplasmosis has been described many times in the USA in horses, dogs, cats, skunks, foxes, monkeys, raccoons, and bears (Menges and associates, 1954).

Attention is merited by the isolation by Emmons (cited by Kashkin, 1962) of a culture of *Histoplasma capsulatum* from a ground-up pasture tick *Dermacentor variabilis* after it had fed on a dog which was sick with histoplasmosis.

Redeelli and associates (1940), who obtained negative results during inoculation of the causative agents of deep mycoses on lower animals and plants, came to the conclusion that the causative agents of coccidioidomycosis, histoplasmosis, and North American blastomycosis are obligate pathogenic parasites of man; in certain higher animals a clinical picture of the disease is noted which is similar to that observed in man.

Thus there is much data in favor of recognition of deep mycoses - coccidioidomycosis and histoplasmosis - as naturally focal (and sometimes anthroponotic) infections with a wide dissemination of the causative agent.

Based on all data, the soil is the main factor in the transmission of the causative agent of deep mycoses. Having entered the soil from the source of infection - an animal (and possibly also man) with excretion, and probably by other routes, the causative agents of deep mycoses, under specific conditions, may be preserved in it for a long time. It is characteristic that in

endemic regions of coccidioidomycosis the causative agent is constantly detected in the burrows of rodents, two times more often than on the surface (Egeberg and Ely, 1956).

Spores of the causative agents are brought into the organism of man primarily with soil dust (air-dust mechanism of infection) or when carrying out excavation work in natural foci, in the event of disturbance and contamination of outer covering layers (contact route of transmission). Considering that clinically deep mycoses sometimes proceed with symptoms of damage to the gastro-intestinal tract (ulcerative colitis), the fecal-oral mechanism of transmission is not excluded.

Apparently in animals the routes of infection are more diverse: digging of burrows, eating infected feed (plants), carcasses, inhalation of infected dust, etc. Relative to the latter it is necessary to mention reports, single for the present, concerning the transmission of coccidioidomycosis by the "contact" route among guinea pigs and monkeys (from mother to cubs) while they were maintained under laboratory conditions (Rosenthal and Elmore, 1950; Castleberry and associates, 1963). Transplacental transmission of histoplasmosis was observed in horses (Top, 1964).

Theoretically it is also possible to assume the transmission of infection from animal to animal by blood-sucking arthropods, ticks in particular.

However, many questions of the epidemiology of deep mycoses still require resolving, and the proposals - experimental confirmation.

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